inContext - Interaction and Context-based Technologies for Collaborative Teams

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Abstract: Much of today's teamwork is based on collaborative working environments (CWEs). These are supporting team members participating in multiple projects at the same time, with the work spanning multiple organisations and the team members working on the move. Virtual, nimble, and mobile teams evolve and merge reflecting the vibrant nature of human interactions. For such teamwork to be supported by computing, flexible, context-aware collaboration services are required. Collaboration environments need to exhibit capabilities for large-scale interactions, peer-to-peer communication, and dynamically adapting software services to enable efficient collaboration. In this paper we discuss how the new techniques and algorithms for relevance-based service aggregation and context-aware service provisioning developed in the inContext project enable dynamic collaboration.

1. Motivations and Objectives

Knowledge Workers are increasingly involved in new kinds of organizational structures and work interaction patterns that require highly dynamic forms of collaboration. New team forms emerge, featuring constantly evolving interaction patterns. These teams change and merge to reflect the dynamic nature of human interaction, switching in most cases from one kind of organizational structure to another. Moreover, workers often engage in many such teams simultaneously, requiring an adequate support from software services.

Collaboration environments (CWEs) need to exhibit capabilities for large-scale interaction and loose coupling in a trusted serviced-oriented way to enable efficient collaboration among team members. CWEs realized as service-oriented architectures need to increasingly emphasise P2P capabilities and the ability to easily adapt collaboration services to different situations by utilizing context information.

Our main goal is to address these challenges by introducing novel techniques and algorithms: on one hand to perform analysis of human-to-human and human-to-service interaction patterns, and on the other hand focusing on context-awareness (the name of the project, inContext, comes from ‘interaction’ and ‘context’), specifically targeting emerging team forms.

As a starting point we try to understand the different types of teams including N/V/M (Nimble/Virtual/Nomadic see [24]), then we establish a context model that addresses the requirements of N/V/M teams, and finally we propose mechanism for ranking and adapting collaboration services using context information.

To fulfil the goals mentioned above, the architecture developed for inContext includes four major elements,

1. Understanding and utilizing diverse types of context information inherent in collaborative working environments.
2. Providing techniques and mining algorithms for analysis of human and service interaction patterns.
3. Providing relevance-based service provisioning and aggregation based on context information and interaction patterns to provide the right service at the right place and the right time.
4. Enabling dynamic collaboration through adaptation strategies for services based on context information gathered across different organisations and collaboration services.

In this paper, we will focus on introducing the overall architecture with respect to the usage of technologies and the real world scenario applications.

2. Methodology

The novel scientific approach that was developed focuses on a blend of human collaboration and service-oriented system. This approach explores two research strands: (1) efficient support for human interactions and collaboration in various teams through aggregated context-aware software services and (2) use of human and service interaction patterns.

2.1 Use case analysis

Two end-user partners and use case providers have been involved from the onset: the Electrolux Group, based in Italy, one of the world's largest manufacturers of white goods, and the West Midlands LGA SMARTregion partnership, one of the biggest regional e-government partnerships in the UK. Their involvement focused on interviews of representatives in the requirements elicitation and extraction phase and subsequently continued by continuous evaluation of the developed software prototypes.

2.2 Understanding emerging team forms

Nimble teams (N-teams) represent team constellations that emerge, engage in work activities, and then dissolve again in a short timeframe, as the circumstances require. Virtual teams (V-teams) consist of people collaborating across geographical distance and professional (organizational) boundaries but have a somewhat stable team configuration with roles and responsibilities assigned to team members. Finally, nomadic teams (also called Mobile teams, or M-teams) allow people working from home, on the move or in flexible office environments, and of course any combinations thereof.

2.3 Understanding the context in Collaborative Working Environments

CWEs must adapt according to the environment and the contextual embedding in which they are used by human collaborators. Service oriented Computing provides the needed flexibility, but requires services to be context-aware – that is aware of the users, and teams and their current activities – to provide the relevant functionality at the right place and the right time. Core of the inContext platform is a context model and a context management framework which allows the required context data to be aggregated, managed and reused across services and organizational boundaries. The designated context model has seven high level key elements (Actions, Activities, People, Time, Team, Location and Resources) to capture the required data. It is also noticeable that some information may not explicitly be presented in the defined context model, it is rather acquired through deductive reasoning techniques.

3. Technology Description

The inContext Pervasive Collaboration Services Architecture (PCSA) (Figure 1) is built on the service-oriented paradigm and is hence highly flexible, allowing new collaboration services to be designed and registered and then used in compositions. This allows for collaborative features to be realized in short time by composing individual services. The focus of the PCSA is to support emerging teams featuring different properties. We have conducted a view based analysis (see [24]) to better understand how the PCSA should support N/V/M teams. In the following sections we discuss the features of the PCSA platform and its usage context.

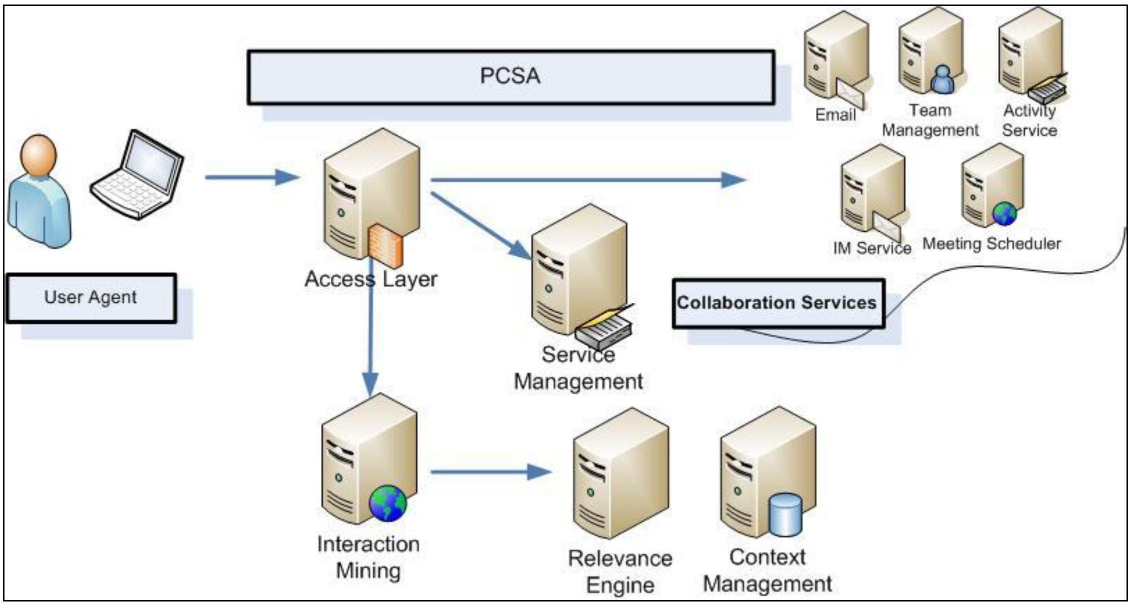

Figure 1: Pervasive Collaboration Services Architecture (PCSA)

Users interact with the various collaboration services through rich user interfaces. User agents can be deployed on regular PCs and mobile devices to support team members of any team form.

As stated, the platform makes use of a set of services which provide the features needed in collaboration such as task management, calendar features and communication capabilities (IM; Email, SMS, Notifications). These services are implemented using state-of-the-art Web services technologies, allowing for easy addition of further services.

The PCSA forms the heart of CWEs build on the inContext technologies and contains 4 main components:

1. The Access Layer provides means to access collaboration services which are deployed within the platform. All interactions are through this layer, which provides security features such as authentication and authorization as well as invoke services and log interactions.
2. The Context Management provides means for storing, retrieving and updating of context information, supporting reasoning and querying capabilities based on Semantic web technology of RDF and SPARQL to provide richer information.
3. The Service Management is concerned with registering and lookup of collaboration services. The service management integrates a novel relevance engine which ranks services according to non-functional properties such as price or availability to provide the most relevant service based on the users context.
4. The Interaction Mining provides various algorithms to detect emerging patterns in collaborations based on human and service interaction logs created by the Access Layer. These patterns are then used to automate human tasks and compositions. For example, interaction patterns help to find the relevant team members (e.g., decision makers) in collaborations.

4. Developments

The inContext project consortium has developed a set of collaboration services (a small set of these services is depicted in Figure 1) and a service management framework for service related information.

Two central aspects of the project are the context model and the service selection mechanism. We will explore each in turn now.

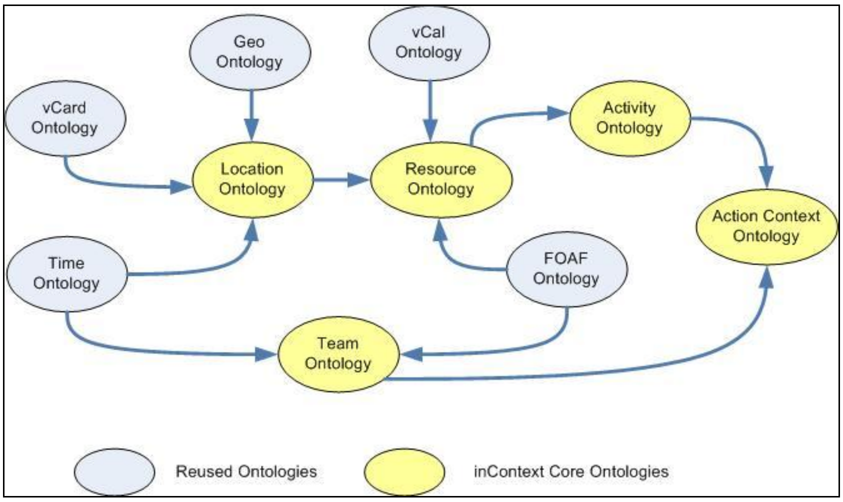

Figure 2: Core Context Model

The devised core context model features the most important characteristics relevant for CWEs supporting emerging teams. The core model has been deliberately kept lightweight and extensible in order to be useful in various CWE domains. Figure 2 shows the context model and the various ontologies, some of which have been defined in the project and some which are partially extended existing ontologies.

The core ontology contains amongst others sub-ontologies for *Activities*, for managing collaborative activities in a structured manner; *Teams*, describing team properties such as size and various dynamics; *Resources*, including documents and services; and *Actions* denoting the temporal properties of executed activities.

The service selection mechanism is based on a Service Repository where the service providers register their collaboration service operations and assign them to categories (e.g. “communication services”). Categories provide an initial set of ranking criteria (non-functional properties, e.g. price or speed). The registry also records further service meta data (an insight of the data model is provided in Figure 3). The Service Lookup handles requests from the access layer containing a functional requirement keyword (e.g. “communication” or “air ticket booking”). Service lookup searches the matched categories and passes a list of relevant ones to the Relevance Engine [4].

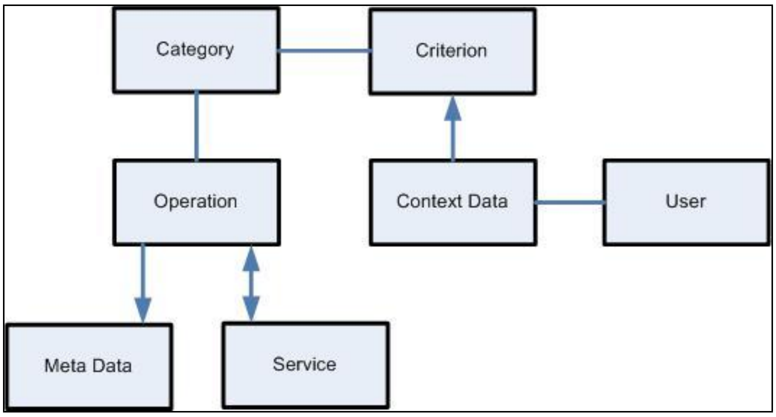

Figure 3: The Conceptual Model for Service Meta Data

The *Relevance Engine* explores the criteria provided with the service list from lookup. It invokes the *Context Parser* to obtain user and service context and adjusts the ranking criteria based on this. Finally, it employs an LSP (Logic Scoring Preference) based ranking method [3] to rank the services, thus providing the intelligence to highlight the most appropriate service for the user’s current needs in the user’s current situation.

5. Applications

Two software prototypes have been developed on top of the PCSA addressing specific and quite diverse business needs expressed by the two end-user organizations. These demonstrate the applicability of the developed techniques and algorithms for relevance-based service aggregation, context-aware service adaptation and provisioning to a wide range of collaborative work-related issues.

Concerning Electrolux test case, a typical situation in collaborative work that such a worldwide company has to deal with on a daily basis is the scheduling of meetings. The inContext platform is helpful for this task, as many of the design objectives occur as issues in this case study. Projects of large multi-nationals usually involve distributed work teams and people who are frequently outside their usual working environment.

Though at first it might seem a trivial problem, scheduling a meeting in this setting usually involves many logistic and organizational difficulties: amongst others, people are in different workplaces, they have different ICT devices available, they have many other engagements, complex agendas, are on the move.

The developed prototype allows to schedule meetings in a complete automatic way, finding the relevant participants and involving the various company members, independent of their location, using the optimal communication channel by finding and invoking the most suitable service. The scheduling is performed by taking decisions about suitable dates in a context-sensitive manner and automatic rescheduling according to existing calendar entries of the meeting participants. Possible substitutes to unavailable participants will also be suggested according to personnel's roles or expertise, and taking into consideration defined rules and policies on attendance priorities.

Also, meeting documentation is managed, where relevant document are selected in a context sensitive way depending on meeting objectives, and made available in a shared document area specifically set up for the meeting.

The second case shows the potential use of the inContext results for a large public event. The event considered is the Annual Community Event held in Wolverhampton, a City and Metropolitan Borough in the West Midlands, England. The town has a population of approximately 250.000, with more than 100.000 households making it the 13th largest city in England.

The Local Authority is known as Wolverhampton City Council employs 35.000 staff in a single location and delivers a range of key services to support the population of the city. These include housing, transport, social services, management of schools, together with a range of leisure activities. It also manages the public recreational spaces, the largest of which is West Park, the location for the annual summer event considered here. In its role as the caretaking agency for the management of open spaces the City Council organises the event, involving staff from many of its departments. Additionally it relies on the involvement of a number of other services, such as the Police, Ambulance and Fire Services, whilst 'guest' organisations may also be involved in a presentational capacity. For the actual two day duration of the event the Council also relies on voluntary participation of many of its own staff.

Because all the activity associated with the event is concentrated into a relatively short time period, the organisational activity to arrange the Fair is quite focused. However, as the key activity of local authorities is in the daily delivery of key services, it is not uncommon to contract additional staff to manage delivery of the event.

For the successful planning and delivery of the event, actors involved in the different activities must be efficiently identified, contacted and coordinated. Actors must be able to communicate and all activities must be planned, started, delivered, closed and key data must be recorded for archive purposes. Subsequently, the body of material created will have to be reviewed each year in order for the lessons learned to be converted into future practice.

6. Conclusion

The inContext consortium has produced working prototypes, which include a series of features to support the needs of emerging team forms. The project partners will also focus on the validation and testing of prototypes, with an effort in identifying new opportunities for future potential exploitation.

Research in areas such as dynamic interaction patterns, context reasoning techniques, relevance-based service provisioning and autonomic service adaptation will have a significant impact on businesses and institutions as knowledge workers greatly increase their efficiency and effectiveness through better integration and improved quality of collaboration.

Furthermore, process awareness enables organizations to improve their risk assessment and management possibilities. Increased flexibility of ad-hoc processes empowers a large section of the society to create virtual organizations and communities.

Relevance-based service provisioning reduces time-to-team and time-to-work, while at the same time increasing productivity, because it helps decreasing irrelevant interruptions. Furthermore, identified best practices and work pattern monitoring support dynamic collaboration in an efficient manner. Finally, inContext's PCSA serves as a tested foundation for further projects and prospective products for areas that can be supported through collaborative work environments.

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